iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 Issue: III Month of publication: March 2023

DOI: https://doi.org/10.22214/ijraset.2023.49837

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue III Mar 2023- Available at www.ijraset.com

An Experimental Investigation on Shear Strength Behaviour of Unsaturated Clays on Effect of Spent Bleaching Earth and Misspend Cement

Pavuluri Satya Muralidhar[1], Ch. Sivanarayana[2]
[1]*PG Student, Department of Civil Engineering, B V C Engineering College, Odalarevu, East Godavari District, Andhra Pradesh, India*
[2]*Associate Professor, Department of Civil Engineering, B V C Engineering College, Odalarevu, EastGodavari District, Andhra Pradesh, India*

Abstract: In any kind of structure, expansive clay is a major cause of undulations. Numerous structures suffer damage and serious problems as a result of expansive soil swelling. The viability and environmental suitability of waste materials are the subject of extensive research by numerous research organizations. Waste products from the cement warehouse and oil industry include wasted bleaching earth and misspend cement. It is the best method to use in expansive soils to avoid issues with dumping and storage. Unconfined compressive strength and tri-axial compressive strength were used to identify a stabilization process. Any structure's stability depends on the strength of the underground soil on which it is built. All of a structure's loads are basically transferred to the ground directly. There are a variety of failures that can occur if the underlying soil is not stable enough to support transferred loads, including structure settlement, cracks, and so on. Soil improvement is necessary to solve this problem because it reduces the risk of structural damage in the future and reduces construction costs. To make ordinary soil stable enough to support the structural loads, a variety of improvements can be made. In this study, both regular and stabilized soil can be used in a number of tests. This paper explains the strength behavior of SBE treated black cotton soil reinforced with MC. The various percentage of SBE as 5%, 10%, 15%, 20% and 25% was used to find out the optimum value of RBI Grade. MC has been randomly included into the SBE treated soil at four different percentages of MC content, i.e. 2%, 4%, 6%, 8% and 10%.
Keywords: Expansive soil, UCS, Tri-Axial, SBE and MC

I. SOIL STABILIZATION

Improving an on-site (in situ) soil's engineering properties is referred to as either "soil modification" or "soil stabilization." The term "modification" implies a minor change in the properties of a soil, while stabilization means that the engineering properties of the soil have been changed enough to allow field construction to take place.

Soil is one of nature's most abundant construction materials. Almost all constructions is built with or upon soil. When unsuitable construction conditions are encountered, a contractor has 4 options.
1) Find a new construction site.
2) Redesign the structure so it can be constructed on the poor soil.
3) Remove the poor soil and replace it with good soil.
4) Improve the engineering properties of the site soils.

In general, Options (1) and (2) tend to be impractical today, while in the past, Option (3) has been the most commonly used method. However, due to improvement in technology coupled with increased transportation costs, Option (4) is being used more often today and is expected to dramatically increase in the future.

A. Objective of the Study

The objectives of the present study are as follows.
1) To evaluate the performance of expansive Clay when treated with SBE as a admixture.
2) To evaluate the performance of expansive Clay reinforced with MC

B. Laboratory Identification

Laboratory identification tests for expansive soils includes grain size analysis, Atterberg's limits, swelling pressure, free swell index test etc., as per IS codes.

The range of physical properties of swelling soils is as follows:
Liquid Limit 40 – 100%
(Exceptionally high for Bentonite)
Plastic Limit 20-60%
Shrinkage Limit 6-18%
Free swell Index 20-150%

Montmorillonite is the prime mineral, which causes the problem of swelling and shrinking. Further, the swelling characteristics depend upon the structure of the soil clay mass and the cation change capacity of the mineral. Hence it is necessary to evaluate the swelling potential of clay mineral. In order to estimate the swelling potential of expansive soils, the following laboratory tests are conducted.

- Free swell test to determine the volume change of the soil.
- Swelling pressure test to evaluate the development of swelling pressure if no volume change of soil is allowed.

Table 1.1, 1.2 and 1.3 give the Chen's Method of Classification, Bureau of Indian Standard classification and USBR classification systems respectively for classifying an expansive soil.

Table 1 Chen's Method of Classification (1965)

Swelling Pressure (Kg/cm^2)	Degree of Expansion
0.5	Low
1.5-2.5	Medium
2.5-9.8	High
>9.8	Very High

Table 2 Bureau of Indian Standards: 1498-1970

Free Swell (Per cent)	Degree of Severity
<50	Non-Critical
50-100	Marginal
100-200	Critical
>200	Severe

Table 3 USBR Classification System (1973)

Shrinkage Limit (Per cent)	Degree of Expansion
>15	Low
10-16	Medium
7-12	High
<11	Very high

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue III Mar 2023- Available at www.ijraset.com

II. DISCUSSION AND RESULTS

Table 2 Variation of Index Properties of Expansive soil with % of SBE

S.No.	Samples	Liquid Limit(%)	Plastic Limit(%)	Plasticity Index(%)
1	100% ES	81.35	31.35	50
2	100% ES+ 5% SBE	78.25	38.23	40.02
3	100% ES+ 10% SBE	74.55	42.12	32.43
4	100% ES+ 15% SBE	68.36	46.32	22.04
5	100% ES+ 20% SBE	64.35	48.96	15.39
6	100% ES+ 25% SBE	60.21	50.85	9.36

Table 3 Expansive soil treated with different percentages of SBE

S.No.	Sample	OMC (%)	MDD (KN/m^3)
1	100% ES	20.55	15.22
2	100% ES + 5% SBE	22.88	15.09
3	100% ES + 10% SBE	24.2	14.99
4	100% ES + 15% SBE	26.21	14.25
5	100% ES + 20% SBE	29.2	14.01
6	100% ES + 25% SBE	31.35	13.89

Table 4 Expansive soil treated with SBE and MC and Obtained OMC & MDD Values

S.No.	**Sample**	**OMC (%)**	**MDD (KN/m^3)**
1	100% ES	21.9	16.22
2	100% ES + 20% SBE+2%MC	30.9	13.01
3	100% ES + 20% SBE+4%MC	32.7	12.75
4	100% ES + 20% SBE+6%MC	36.18	14.0
5	**100% ES + 20% SBE+8%MC**	**37.23**	**13.03**
6	100% ES + 20% SBE+10%MC	37.3	12.89

Table 5 Expansive soil treated with SBE and Obtained DFS Values

S.No.	Particulars	DFS %
1	100% ES	148
2	100% ES + 5% SBE	121
3	100% ES + 10% SBE	101
4	100% ES + 15% SBE	95
5	100% ES + 20% SBE	89
6	100% ES + 25% SBE	84

Table 6 Expansive soil treated with SBE and MC and Obtained DFS Values

S.No.	Particulars	DFS %
1	100% ES	148
2	100% ES + 20% SBE	89
3	100% ES + 20% SBE+5%MC	82
4	100% ES + 20% SBE+10%MC	76
5	100% ES + 20% SBE+15%MC	71
6	100% ES + 20% SBE+20%MC	65
7	100% ES + 20% SBE+25%MC	61

Table 7 Expansive soil treated with SBE and Obtained Soaked & Un-soaked CBR values

S.No.	Particulars	CBR % (Un-Soaked)	CBR % (Soaked)
1	100% ES	2.58	1.88
2	100% ES + 5% SBE	3.5	2.3
3	100% ES + 10% SBE	4.2	2.9
4	100% ES + 15% SBE	4.7	3.5
5	100% ES + 20% SBE	5	4
6	100% ES + 25% SBE	5.2	3.6

Table 8 Expansive soil treated with SBE and MC and Obtained Soaked & Un-soaked CBR values

S.No.	Particulars	CBR % (Un-Soaked)	CBR % (Soaked)
1	100% ES	2.58	1.88
2	100% ES + 25% SBE	5	4
3	100% ES + 20% SBE+2%MC	5.5	4.38
4	100% ES + 20% SBE+4%MC	6.2	4.98
5	100% ES + 20% SBE+6%MC	7	5.8
6	100% ES + 20% SBE+8%MC	8.5	6.6
7	100% ES + 20% SBE+10%MC	8.4	6.4

Table 9 Expansive soil treated with SBE and Obtained UCS Values

S No	Particulars	Days UCS(kN/m2)			
		0	7	14	28
1	100% ES	350	350	350	350
2	100% ES + 5% SBE	415	445	575	680
3	100% ES + 10% SBE	470	515	710	790
4	100% ES + 15% SBE	520	625	880	900
5	100% ES + 20% SBE	571	680	1001	1050
6	100% ES + 25% SBE	559	650	998	1000

Table 10 Expansive soil treated with SBE and MC and Obtained UCS Values

S No	Particulars	Days UCS(kN/m2)			
		0	7	14	28
1	100% ES	350	350	350	350
2	100% ES + 20% SBE	571	680	1001	1050
3	100% ES + 20% SBE+2%MC	740	880	970	1100
4	100% ES + 20% SBE+4%MC	950	1025	1200	1340
5	100% ES + 20% SBE+6%MC	1229	1350	1430	1570
6	100% ES + 20% SBE+8%MC	1340	1510	1740	1740
7	100% ES + 20% SBE+10%MC	1295	1440	1700	1720

Table 11 Shear strength properties (KPa)

Materials added to the soil	Percentage of materials added to the soil	Shear strength properties (KPa)					
		1 day		7 days		14days	
		Cohesion, C_u (kg/cm^2)	Angle of internal friction, ϕ, (Deg.)	Cohesion, C_u (kg/cm^2)	Angle of internal friction, ϕ, (Deg.)	Cohesion, C_u (kg/cm^2)	Angle of internal friction, ϕ, (Deg.)
Without material	0	0.56	2^0	0.56	--	0.56	--
SBE	2	0.61	3^0	1.11	5^0	1.28	6^0
	4	0.72	5^0	1.23	6^0	1.32	7^0
	6	0.65	6^0	1.15	8^0	1.26	7^0
	8	0.63	7^0	1.10	8^0	1.24	8^0
100%ES + 20% SBE + % MS	5	0.79	2^0	1.25	4^0	1.36	6^0
	10	0.89	3^0	1.28	5^0	1.39	7^0
	15	0.86	4^0	1.25	5^0	1.33	6^0
	20	0.83	4^0	1.34	6^0	1.32	6^0

III. CONCLUSIONS

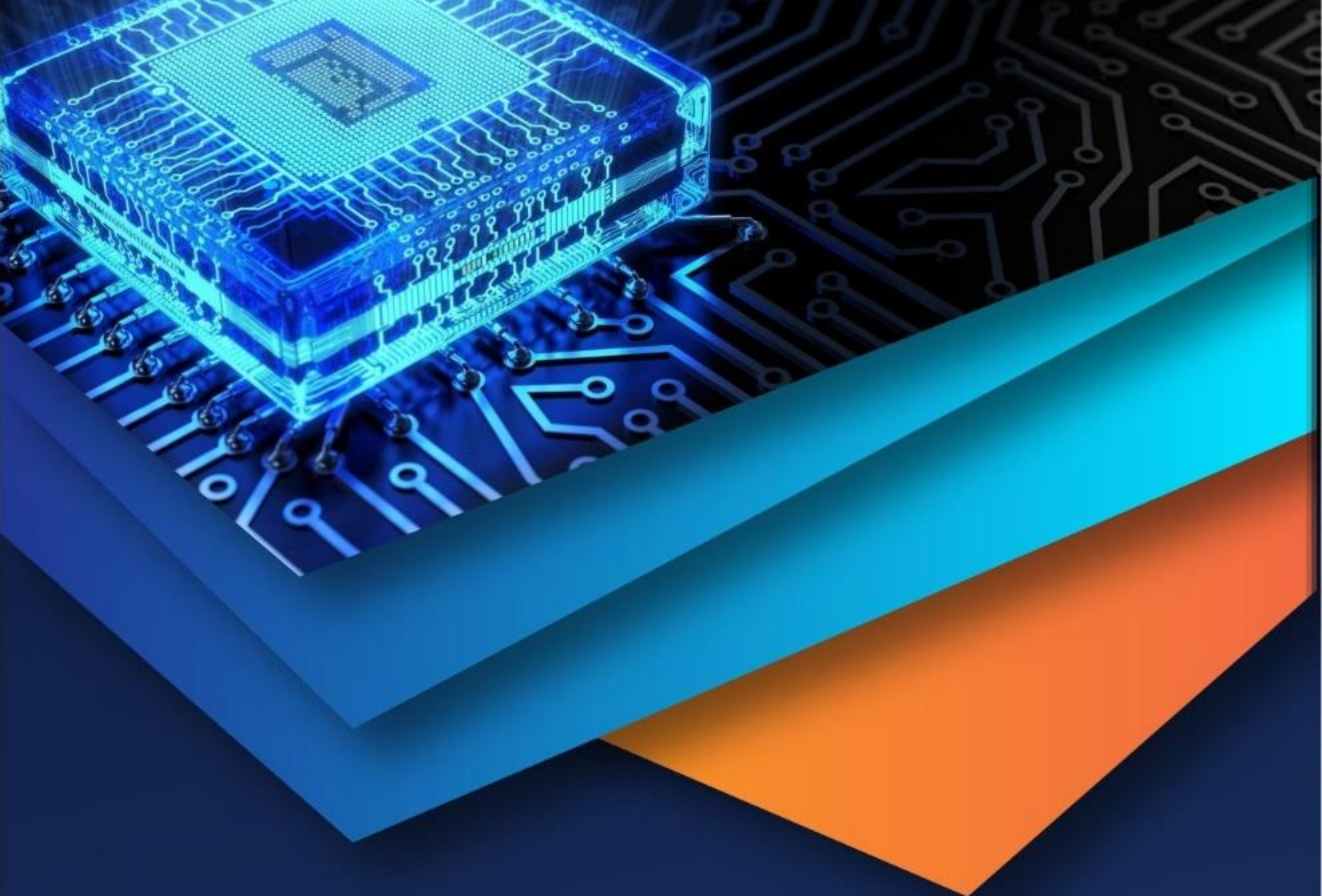
1) When SBE is increased from 0 to 25 percent, the results of Liquid Limit tests on extensive soil treated with various percentages of SBE show that the liquid limit of the soil decreases from 81.35 percent to 60.21 percent. When SBE is increased from 0 to 25%, the plastic limit of expansive soil decreases from 31.55% to 50.85%, according to the results of plastic limit tests on soil treated with various percentages of SBE. The Plasticity Index of expansive soil treated with various percentages of SBE shows that when SBE is increased from 0 to 25%, the plasticity Index of the soil decreases from 50 percent to 9.36 percent.
2) Compaction tests on extensive soil treated with varying percentages of SBE revealed a decrease in MDD with increasing SBE addition, while OMC increased on the other side. When SBE is added at a rate of 20%, the soil's MDD continues to decrease from 0% to 8%. Compaction tests on extensive soil treated with varying percentages of SBE revealed a decrease in MDD with increasing SBE addition, while OMC increased on the other side. When SBE is added at a rate of 20%, the soil's OMC continues to rise from 0% to 42%. Compaction tests on extensive soil treated with 20 percent SBE and various percentages of MC revealed a decrease in MDD with increasing addition of MC and 20 percent SBE, while OMC increased on the opposite side. The MDD of soil continues diminishing from 0% to 14.58% when SBE added at 20% as displayed in fig. 5.6. Compaction tests on extensive soil treated with 20% SBE and various MC percentages revealed a decrease in MDD with increasing SBE addition and an increase in OMC on the other side. When SBE is added at 20% and 8% MC, the soil's OMC continues to rise from 0% to 76.30%.

3) The results of DFS tests on expansive soil treated with different percentages of SBE can be observed that the Decrease of DFS with the increasing addition of SBE. The DFS of soil goes on decreasing from 0% to 76.10% at added 20%SBE. The results of DFS tests on expansive soil treated with 20% SBE and different percentages of MC can be seen that the Decrease of DFS with the increasing addition of MC and 20% SBE. The DFS of soil goes on decreasing from 0% to 142% when SBE added at 10%.
4) The results of CBR tests conducted on extensive soil that had been treated with varying amounts of SBE can be seen to increase as the amount of unsoaked CBR increases. The Un-Splashed CBR of soil continues expanding from 0% to 93.70% by adding 20% SBE. The results of CBR tests performed on extensive soil that had been treated with varying amounts of SBE can be seen to increase as the amount of SBE added increases. When SBE occurs, the Soaked CBR of the soil continues to rise from 0% to 91%. The consequences of CBR tests on broad soil treated with 20% SBE and various rates of MC should be visible that the increment of Un-Splashed CBR with the rising expansion of MC and 20% SBE. The Un-Drenched CBR of soil continues expanding from 0% to 229% when SBE added at 20% and various rates of MC. The increase in Soaked CBR with increasing addition of MC and 8% SBE can be observed in the results of CBR tests conducted on extensive soil treated with 20% SBE and various percentages of MC. When SBE is added at a rate of 20% and various percentages of MC, the Soaked CBR of the soil continues to increase from 0% to 251%. On large areas of soil that had been treated with varying amounts of SBE, the results of UCS tests show that the amount of SBE added increases the amount of UCS. By adding 20% SBE, the soil's UCS continues to rise from 0% to 200 for 28 days. The results of UCS tests on extensive soil that had been treated with 20 percent SBE and various percentages of MC show that the amount of MC and 20 percent SBE added increases the amount of UCS. When SBE is added at a rate of 8% and various percentages of MC are added, the UCS of the soil continues to rise for 28 days, going from 0% to 397%.

REFERENCES

[1] Ramesh, H.N., K.V. Manoj Krishna and H.V. Mamatha (2010) “Compaction and strength behaviour of ESP-coir fiber treated black cotton soil”, geomechanics and Engineering, Vol. 2., No. 1 19-28.
[2] Kaniraj, S.R. and Vasant, G.H. (2001), “Behavior of cement-stabilized fiber reinforced fly ash soil mixture”,Geotech. Geoenviron. Eng. J, 574-584.
[3] Kaniraj, S.R. and Gayathri, V. (2003), “Geotechnical Behavior of fly ash mixed with randomly oriented fiber inclusions”, Geotext. Geomembranes, 21, 123-149.
[4] Nagu, P.S., Chandrakaran, S. and Sankar, N. (2008), “Behaviour of ESP stabilized clayey soil reinforced with Nylon fibers”, Proceedings of ’08 International Conference on Geotechnical and Highway Engineering, Geotropika, Kuala Lumpar, Malaysia, May.
[5] Kavitha. S and Dr. T. Felix Kala, “ESP Analysis by Scanning Electron Microscope Study”. International Journal of Civil Engineering and Technology (IJCIET), 7(4), 2016, pp.234–241.
[6] Jamei M., Villard P. and Guiras H.,(2013), “ Shear Failure Criterion Based on Experimental and Modeling Results for Fiber-Reinforced Clay”, Int. J. Geomech.,(ASCE), 13(6): 882-893
[7] Jiang H., Cai Y. and Liu J, (2010) “Engineering Properties of Soils Reinforced by Short Discrete Polypropylene Fiber”, J. Mater. Civ. Eng., (ASCE), 22(12): 1315-1322
[8] Sabat A.K., (2012), “A Study on Some Geotechnical Properties of ESP Stabilised Expansive Soil –Quarry Dust Mixes”, International Journal of Emerging trends in Engineering and Development, Issue 2, Vol.1, 42-49
[9] Venkateswarlu H., Prasad A.C.S.V., Prasad D.S.V. & Raju G.V.R.P., (2015) “ Study on Behavior of Expansive Soil Treated With Quarry Dust”, International Journal of Engineering and Innovative Technology (IJEIT) Volume 4, Issue 10, 193-196.
[10] V Paul John and M Antony Rachel Sneha, “Effect of Random of ESPs on Strength Behaviour of FlyAsh Treated Black Cotton Soil,”International Journal of Civil Engineering and Technology (IJCIET),Volume 7, Issue 5,pg. 153–160 September-October 2016
[11] Hussain, M. and Dash, S. K. (2009), “Influence of ESP on Compaction Behaviour of Soils”, Geotides, Indian Geotechnical Conference, Guntur, India, IGC-2009.
[12] B.R. Phanikumar,C. Amshumalini and R. Karthika(2009)”Effect of ESP on Engineering Behavior of Expansive Clays”, IGC- 2009,Guntur,pp.80-82.
[13] Siddique, A. M. and Hossain, A. (2011), “Effects of ESP Stabilization on Engineering Properties of an Expansive Soil for Use in Road Construction.” Journal of Society for Transportation and Traffic Studies, 2(4).
[14] Pankaj R. Modak, Prakash B. Nangare, Sanjay D. Nagrale, Ravindra D. Nalawade, Vivek S. Chavhan(2012), “Stabilization of black cotton soil using admixtures” International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue
[15] Akshaya Kumar Sabat (2012), “A Study on Some Geotechnical Properties of ESP Stabilised Expansive Soil –Quarry Dust Mixes”. International Journal of Emerging trends in Engineering and Development, Issue 2, Vol.1.
[16] P.V.Koteswara Rao, K.Satish Kumar and T.Blessingstone, (2012),”Performance of Recron-3s Fiber with Cement Kiln Dust in Expansive Soils”, International Journal of Engineering Science and Technology (IJEST), Vol. 4 No.04, pp.1361-1366.
[17] Monica Malhotra and Sanjeev Naval (2013), “Stabilization of Expansive Soils Using Low Cost Materials” International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 11, May 2013,pp.181-184.
[18] The need for soil stabilization, April 9, 2011 by Ana [online] Available at: < http://www.contracostalandscaping.com/the-need-for-soil-stabilization/
[19] Methods of soil stabilization, December 24, 2010 [online] Available at: < http://www.engineeringtraining.tpub.com/14070/css/14070_424.htm
[20] Prof. Krishna Reddy, UIC, 2008, Engineering Properties of Soils Based on Laboratory Testing
[21] Understanding the Basics of Soil Stabilization: An Overview of Materials and Techniques [online] Available at: <http://www.cat.com
[22] Punmia B.C. 2007, “Soil Mechanics & Foundations” Laxmi Publication

[23] IS-2720 part 3 (1985) (Reaffirmed 1995). Indian standard Method of test for soils. Specific gravity. Bureau of Indian standards, New Delhi
[24] IS-2720 part IV (1985) (Reaffirmed 1995). Indian standard Method of test for soils. Grain size analysis. Bureau of Indian standards, New Delhi
[25] IS-2720 part V (1985) (Reaffirmed 1995). Indian standard Method of test for soils. Determination of liquid and plastic limit. Bureau of Indian standards, New Delhi
[26] IS-2720 part VI (1972) (Reaffirmed 1995). Indian standard Method of test for soils. Determination of Shrinkage factor. Bureau of Indian standards, New Delhi
[27] IS-2720 part VII (1980) (Reaffirmed 1999). Indian standard Method of test for soils. Determination of water content-dry density relation using light compaction. Bureau of Indian Standards, New Delhi
[28] IS – 2720 part 10 (1987). Indian Standard Method of test for soils. Laboratory Determination of UCS. Bureau of Indian standards, New Delhi
[29] IS – 2720 part 16 (1987). Indian Standard Method of test for soils. Laboratory Determination of CBR. Bureau of Indian standards, New Delhi.
[30] IS-2720 part 40 (1985) (Reaffirmed 1995). Indian standard Method of test for soils. Free swelling index. Bureau of Indian standards, New Delhi



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY